Meeting NSW Electricity Needs in a Carbon Constrained World:

Lowering Costs and Emissions with Distributed Energy

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Intelligent Grid Research Program

Project 4: Institutional Barriers, Economic Modelling and Stakeholder Engagement

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Abbreviations

AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
CCGT	combined cycle gas turbine
CCS	carbon capture and storage
CEC	Clean Energy Council
CPRS	Carbon Pollution Reduction Scheme
DE	Distributed Energy
DSR	Demand Side Response
IGCC	integrated gasification combined cycle (coal power station)
MEPS	Minimum Energy Performance Standards
RET	Mandatory Renewable Energy Target
NEMMCO	National Electricity Market Management Company
OGT	open cycle gas turbine
POE	Probability of Exceedance
SOO	Statement of Opportunities

Glossary

Capacity for reliability	The capacity required to meet maximum demand at 10% POE plus the minimum reserve level.
Distributed Energy	Energy supply and management options close to where the energy is used. Distributed Energy includes: local generation, end use energy efficiency, and peak load management (also called 'demand side response', or DSR).
Native energy	The electrical energy supplied by both scheduled generating units and significant non-scheduled generating units.
Non-scheduled generation	A generating unit that is not scheduled by NEMMCO as part of the central dispatch process.
Non-scheduled demand	That part of the electricity demand supplied by non-scheduled generating units.
Peak Demand	The highest amount of electrical power required, or forecast to be required, over a defined period (day, week, month, season or year)
Probability of Exceedance (POE)	The probability, as a percentage, that a maximum demand (MD) level will be exceeded (for example, due to weather conditions) in a particular period. For example, for a 10% POE maximum for any given season, there is a 10% probability that the level will be met or exceeded. Consequently, 10% POE levels are expected to be exceeded, on average, 1 year in 10.
Scheduled generation	Generation from scheduled generators; that is, dispatched through NEMMCO's central dispatch process (so generators bid into the market).

Executive Summary

Communities in developed nations expect their governments to ensure the reliable supply of electricity. Reflecting these expectations, the NSW Government established an Inquiry into Electricity Supply in NSW in 2007, chaired by Professor Anthony Owen (the "Owen Inquiry"). This Inquiry was asked in particular to review the need and timing for new baseload supply.

The Owen Inquiry concluded that there was a potential shortfall in baseload supply from 2013/14, and recommended that planning for new power stations should commence immediately as the lead time for a coal-fired power station could be 6–7 years.

Since the Owen Inquiry, the projections for both electricity consumption and electricity generation have been modified significantly (Transgrid 2008), such that the findings of the Inquiry warrant substantial reconsideration.

It is beyond the scope of this report to review the merits of the privatisation plan proposed by the Owen Inquiry. However, it may well prove fortuitous for NSW that the Owen Inquiry's recommendations were not adopted, as this means there is an opportunity to reconsider the options for securing the state's electricity future.

This report examines the current projections for energy consumption and generation, and how they differ from the Owen Inquiry results. It then examines peak demand projections, and identifies when potential shortfalls may occur. Finally, three Distributed Energy and two centralised energy scenarios that meet potential shortfalls are compared for greenhouse gas emissions and costs.

Energy generation potential shortfall

At the time of the Owen Inquiry, a potential energy generation shortfall was identified of 2,500 GWh in 2013/14. This shortfall was expected to rise to 11,600 GWh by 2020. However, these forecasts have since been substantially revised. The projected shortfall now only appears in 2017, and by 2020 reaches only 3,800 GWh[1].

These changes are essentially because additional renewable generation has been included in the official projection to take account of the new national Renewable Energy Target (RET) for 20% renewable electricity by 2020, and because the projection for energy consumption is lower due to lower projected economic growth.

However, even the revised energy shortfall disappears if moderate energy efficiency measures are put in place. Rather than an energy shortfall, there is the possibility of a surplus of electricity generation potential of more than 12,000 GWh by 2019/20 provided the following conditions are met:

- Energy efficiency measures identified in this report are adopted. These include more efficient commercial lighting, and industrial and residential energy efficiencies. These measures will take the potential surplus supply to 3,900 GWh;
- 700 MW of cogeneration is put in place. This will take the potential excess supply to 9,700 GWh.
- 50% of the Snowy Mountains Hydro-Electric Scheme output is available to NSW, and a 12.5% proportion of Australia's expected growth in scheduled renewable energy investment occurs in NSW. This takes the surplus in generation potential to 12,800 GWh by 2020.

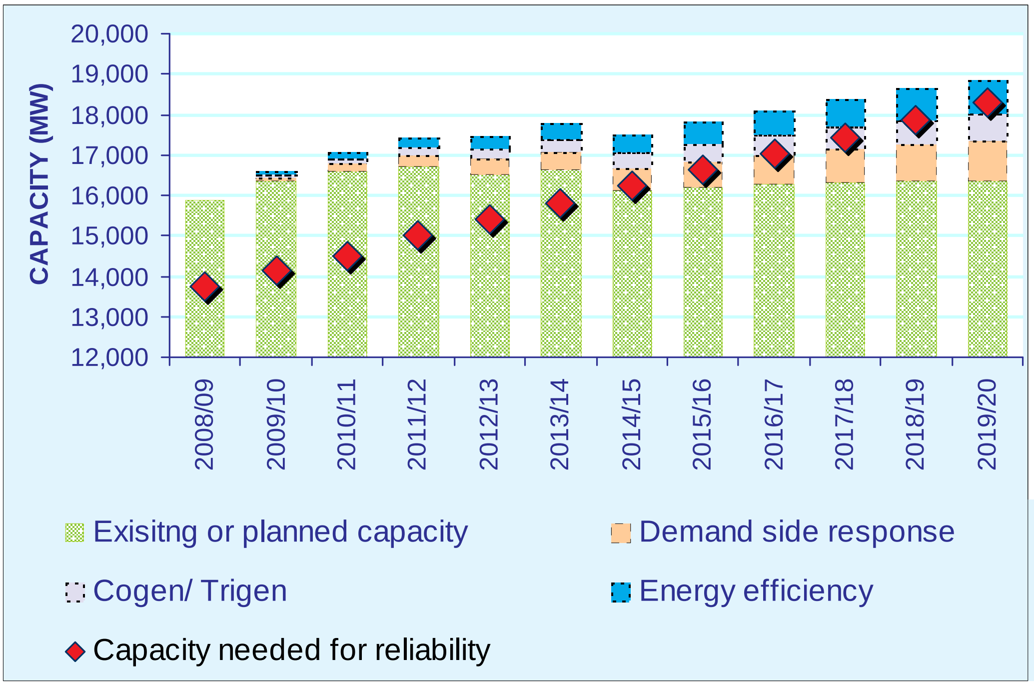
[1] These figures are from the 2007 and 2008 Transgrid Annual Planning Reports, which are the basis of the Owen report (Transgrid 2007) and the current projection (Transgrid 2008).

Peak generation capacity shortfall

While the revised forecasts have reduced or eliminated the expected shortfall in annual energy generation potential, there remains a significant expected shortfall in generation capacity to meet peak demand. This amounts to 390 MW in 2014/15, rising to 1,900 MW in 2019/20. This projection may overestimate the shortfall, as it assumes coincident maximum demand in all states. The shortfall corresponds to the capacity needed for reliable electricity supply, including both scheduled and non-scheduled energy, at 10% Probability of Exceedance (POE). The projections are from the NEMMCO 2008 Statement of Opportunities, and are likely to be revised downwards as a result of the global economic slowdown.

However, the current projected capacity shortfall can be comfortably met by “Distributed Energy” options, even with the conservative assessment of resources identified in this report. Distributed Energy refers to energy supply and management options deployed close to where the energy is used, and includes local generation, end use energy efficiency, and peak load management (also called ‘demand side response’, or DSR).

Potential of Distributed Energy to meet forecast capacity needs to 2020.



The scenarios

This Report considers five scenarios:

Scenario A. ***Coal***: a coal fired power station comes online in 2017/18, followed by additional open cycle gas turbines from 2018/19. This is the closest to the scenario suggested by the Owen Inquiry, although the investment date suggested in Owen was earlier and the energy shortfall greater.

Scenario B. ***Gas***: a combination of open cycle (OCGT) and combined cycle gas turbines is used to meet capacity shortfalls as assumed in the 2008 NEMMCO projections.

Scenario C. ***Cogeneration and demand side response***: the shortfall in capacity is met by a combination of cogeneration and demand side response.

Scenario D. ***Energy efficiency and demand side response***: the shortfall in capacity is met by a combination of energy efficiency and demand side response (DSR).

Scenario E. ***Combined Distributed Energy***: the measures identified in this report (energy efficiency, cogeneration, and demand side response) are all adopted, and coal fired power capacity is reduced by 1000 MW in 2014/15.

Costs and greenhouse emissions

The most expensive scenario is the one closest to the Owen Inquiry recommendations, namely building a new coal fired power station ($30.7 billion cumulative cost). This is also the most greenhouse intensive option. The gas scenario, is the next most expensive at $29.8 billion.

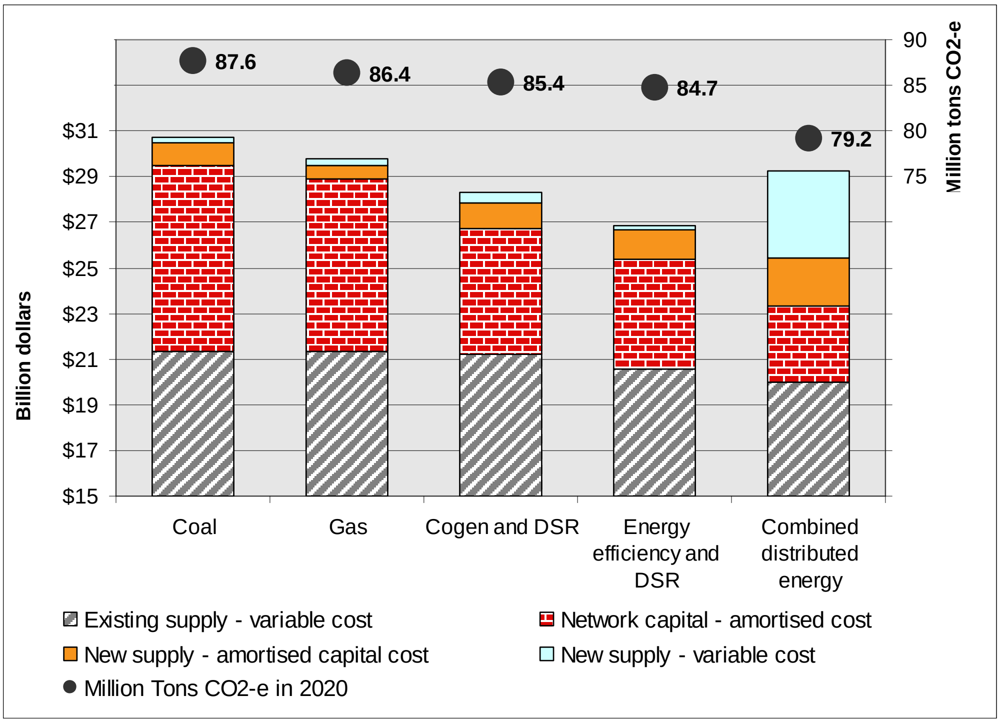
All three Distributed Energy scenarios are cheaper, ranging from $26.8 billion to $28.3 billion.

The Combined Distributed Energy scenario (Scenario E), which includes efficiency, DSR, cogeneration and reducing coal fired capacity, has the lowest greenhouse gas emissions, with an annual saving by 2020 of 7 million tonnes compared to the gas scenario. It also costs $0.5 billion less than the gas scenario (Scenario B). This combined Distributed Energy scenario is even more attractive when compared to building a new coal fired power station (Scenario A), because it costs $1.5 billion less and produces 8.4 million tonnes less greenhouse emissions.

The Energy Efficiency and Demand Side Response Scenario (Scenario D), has the lowest cost, saving about $620 million per year, or about $60 per household in 2020 when compared to the Coal scenario (Scenario A). It also saves 2.9 million tons of carbon dioxide in 2020.

As indicated below the key component of the cost savings is the savings on network infrastructure augmentation.

Cumulative cost and annual greenhouse emissions up to 2020



Conclusions

Meeting the growth in demand with Distributed Energy is significantly cheaper than building a new coal fired power station or meeting electricity growth needs with gas turbines. This is primarily because of significant savings which can be achieved by avoiding or deferring the need for expensive electricity network augmentation.

The Distributed Energy scenarios also have lower greenhouse gas emissions, particularly if combined with retiring 1000MW of coal fired generation. The maximum Distributed Energy scenario considered (energy efficiency, cogeneration, demand side response and retiring 1000 MW of coal fired generation) saves 7 million tonnes of emissions and $0.5 billion compared to business as usual.

However, these economic and environmental benefits will not be realised unless there is deliberate and effective electricity policy reform in NSW. This policy reform does not need additional government funding, but it does require strong and sustained political leadership to break with the centralised energy paradigm of the past.

In order to accelerate the development of Distributed Energy in NSW the following reforms are recommended.

Recommendation 1:

The NSW Government should adopt a target of meeting all forecast growth in energy consumption and peak demand between 2010 and 2020 from "green" energy sources; that is, renewable energy and Distributed Energy (including energy efficiency, demand side response, and cogeneration).

Recommendation 2:

The NSW Government should nominate a suitable agency within Government with appropriate resources and authority to coordinate its Distributed Energy strategy to implement these recommendations.

Recommendation 3:

The NSW Government should undertake and publish a comprehensive annual NSW Distributed Energy Review. This Review should include

- ***a detailed resource assessment of Distributed Energy potential in NSW,***
- ***a detailed assessment of current Distributed Energy practice in NSW,***
- ***an overview of international best practice in programs and policy, and***
- ***an evaluation of potential policy measures for the adoption of Distributed Energy.***

Recommendation 4:

The NSW Government should maximise incentives for Distributed Energy by:

- ***accelerating and better targeting existing programs (such as the NSW Climate Change Fund)***
- ***making greater use of non-financial incentives and community engagement and***
- ***encouraging NSW Government-owned electricity network operators to redirect part of their capital budgets towards incentives for Distributed Energy.***

Recommendation 5:

The NSW Government should continue to advocate for an effective and adequate national price on carbon emissions in the context of the CPRS. Until this is achieved it should reinforce NSW-based measures (such as the NSW Greenhouse Gas Abatement Scheme) that redress the price bias against lower emission Distributed Energy options.

Recommendation 6:

The NSW Government should encourage its distribution network businesses to accelerate the deployment of smart meters and the introduction of time-of-use pricing, (including dynamic peak pricing at times of very high demand offset by lower prices at other times). It should also encourage Transgrid to reform transmission network pricing to strongly reflect peak load events in its prices.

Recommendation 7:

The NSW Government should request that the Australian Energy Market Commission (AEMC) change the National Electricity Rules to remove regulatory biases against Distributed Energy by:

- ***removing network regulatory incentives which are contrary to the consumer interest (such as the current link between network profits and customer electricity sales volume).***
- ***allowing network businesses to invest in Distributed Energy options up to five years prior to the corresponding trigger point for network augmentation.***
- ***requiring network businesses to implement all available cost effective Distributed Energy options with lower greenhouse gas emissions prior to augmenting the network.***

1 Introduction

A reliable electricity supply is an essential service in modern economies, and governments have a crucial role in ensuring their continuing adequacy and reliability. To this end, the NSW Government established an Inquiry into Electricity Supply in NSW in 2007, chaired by Professor Anthony Owen (the "Owen Inquiry"), which specifically reviewed the need and timing for new baseload supply.

The Owen Inquiry found that new baseload power could be required from 2013/14. The Inquiry found that without a new source of baseload power, there was a potential shortfall of up to 2,400 GWh, rising to 11,600 GWh by 2017/18. The Inquiry further recommended that planning should commence for a new baseload power station during 2007, as the lead time for a coal power station could be 6–7 years.

The findings of the Inquiry were based on electricity consumption forecasts derived from the Annual Planning Report of the NSW Government-owned transmission company, Transgrid (Transgrid 2007), with additional information from commissioned reports (Connell Wagner 2007; Wood Mackenzie 2007; Morgan Stanley 2007).

Since the Owen Inquiry the landscape for energy in NSW has changed significantly. The federal government has committed to raise the national Renewable Energy Target (RET) to 20% of total national electricity supply by 2020, equivalent to a fourfold increase in electricity supplied from renewable energy or 45,000 GWh per year. Largely as a result of the expanded RET, "non-scheduled"[2] generation projections are more than double those made in 2007[3]. Future consumption estimates have also been revised downwards because of both energy efficiency and reduced expectations for economic growth, and are likely to be further reduced as a result of the current global economic slowdown.

Overall, the projections for both electricity consumption and electricity generation have been modified significantly (Transgrid 2008), such that the findings of the Owen Inquiry warrant substantial reconsideration.

This report examines the current projections for energy consumption and generation, and how they differ from the Owen Inquiry results. It identifies the timing and magnitude of the currently projected energy shortfalls.

The report then examines peak demand projections, using data from the National Electricity Market Management Company (NEMMCO), and identifies when shortfalls may occur in summer peak consumption periods, as these are the maximum peaks projected for NSW.

Finally, the potential for Distributed Energy to meet the projected growth in NSW electricity needs is considered. Distributed Energy refers to energy supply and management options deployed close to where the energy is used, and includes local generation, end use energy efficiency, and peak load management (also called 'demand side response', or DSR).

[2] Non-scheduled generators do not have their output controlled through a centralised despatch process run by NEMMCO, either because their output is 'non-despatchable' and automatically goes into the grid (for example wind generation), or because all output is consumed on site, or sold directly to a local electricity retailer or local customer.
[3] Transgrid (2007) compared to Transgrid (2008)

Three Distributed Energy and two centralised generation scenarios are compared for both greenhouse emissions and costs:

Scenario A. ***Coal***: a coal fired power station comes online in 2017/18, followed by additional open cycle gas turbines from 2018/19 (this is the closest to the scenario suggested by the Owen Inquiry, although the investment date suggested in Owen was earlier and the energy shortfall greater).

Scenario B. ***Gas***: a combination of open cycle (OCGT) and combined cycle gas turbines is used to meet capacity shortfalls as assumed in the 2008 NEMMCO projections.

Scenario C. ***Energy efficiency and demand side response***: the shortfall in capacity is met by a combination of energy efficiency and demand side response.

Scenario D. ***Cogeneration and demand side response***: the shortfall in capacity is met by a combination of cogeneration and demand side response.

Scenario E. ***Combined Distributed Energy***: the measures identified in this report (energy efficiency, cogeneration, and demand side response) are all adopted, and coal fired power capacity is reduced by 1000 MW from 2014/15.

2 Energy consumption and supply projections for NSW

2.1 Owen (2007) projections and current (2008) projections

Electricity consumption and the potential shortfalls in supply projected at the time of the Owen Inquiry and one year later, in 2008, are shown in Figures 1 and 2 below. The data in both figures come from Transgrid, as the Transgrid 2007 planning report was the source of energy projections for the Owen Inquiry.

At the time of the Owen Inquiry, a potential shortfall was identified of 2,500 GWh in 2013/14, rising to 11,600 GWh by 2020. One year later, these projections have been revised. The shortfall only appears in 2017, and by 2020 has reached only 3,800 GWh.[4]

This is entirely consistent with the changes in projected consumption and generation identified in the 2007 and 2008 Transgrid Annual Planning Reports.

Consumption projections

At the time of the Owen inquiry, Transgrid's medium projection was that electricity consumption would reach 96,450 GWh by 2016/17, with an average growth rate of 1.8% from 2007/8 to 2016/17 (Transgrid 2007). By 2008, this had been reduced to 94,680 GWh with a growth rate of 1.6% (Transgrid 2008). The medium projection for electricity consumption in NSW in 2016/17 was reduced by 2,500 GWh (2.5%) (Transgrid 2007 and 2008).

This reduction in projected electricity consumption is primarily because projections for economic growth were reduced, and because committed minimum energy performance standards (MEPS) were explicitly included in the 2008 modelling (Transgrid 2008, p. 21).

Generation projections

The projections for electricity generation from NSW existing or committed non-scheduled power stations in 2016/17 increased by 4,700 GWh (NEIR 2008), largely as a result of the increased RET target.

The estimated non-scheduled generation in NSW in 2017 increased from 4,000 GWh (Transgrid 2007) to 8,700 GWh (Transgrid 2008), with 5800 GWh resulting from the additional RET target (NIEIR 2008 Table B2 and Table 4).

The approach taken by this report

This report takes the 2008 figures as a starting point, as it is assumed that energy planning in NSW should be based on the most recent available data. This suggests a potential energy shortfall of 2,200 GWh appearing in 2018/19, and rising to 3,800 GWh in 2019/2020. Later sections of the report examine the least cost means of avoiding that shortfall. Moreover, this report argues that prudent energy planning must consider the climate change implications, both in relation to investment choices and in relation to current and likely policy responses.

[4] The Transgrid and Owen Inquiry projections only go to 2017/18. In this report all projections have been extended to 2020 using the annual growth rates identified in these reports.

Figure 1 NSW electricity to 2020 – Owen Inquiry projection (2007)

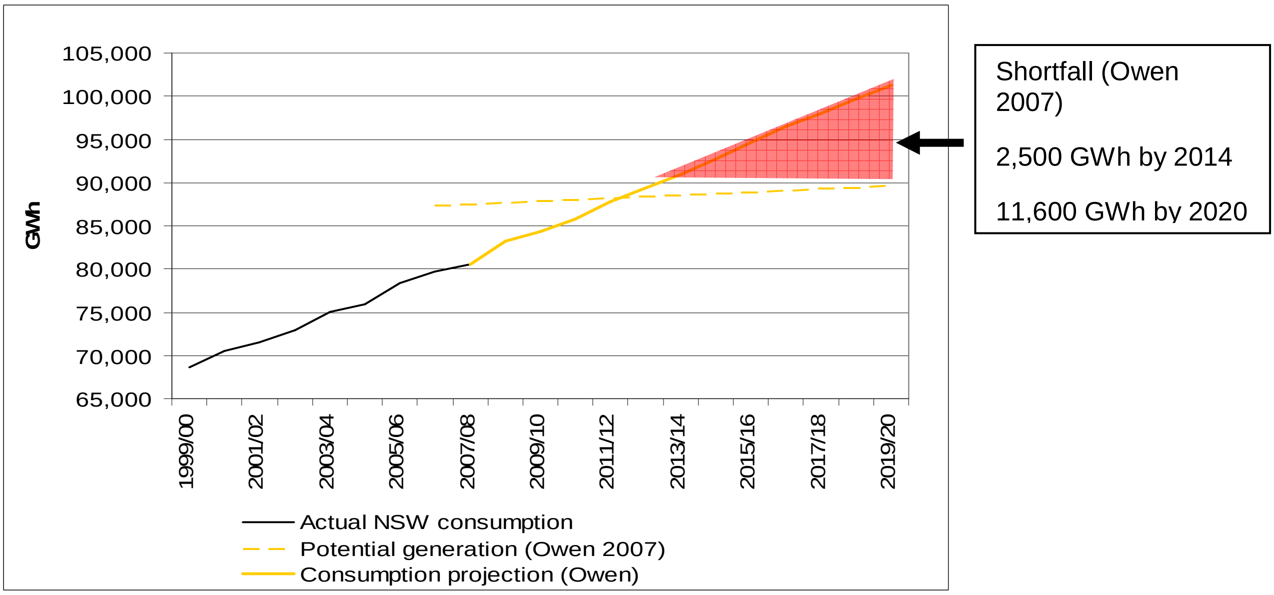
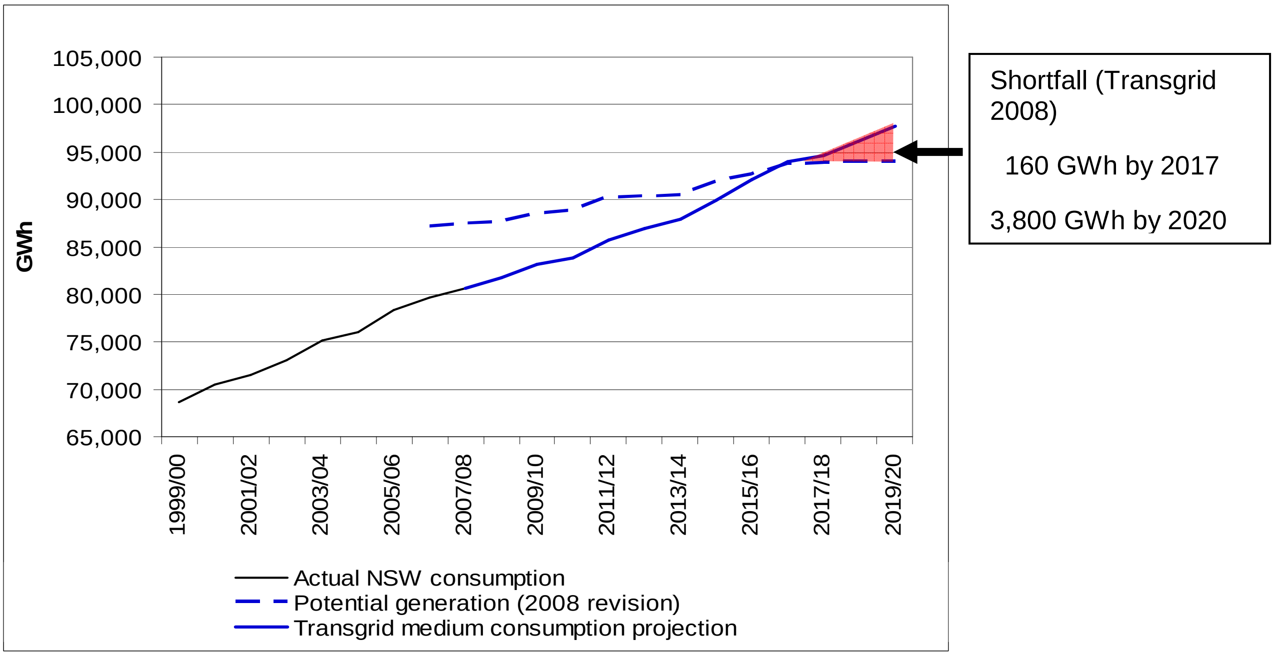


Figure 2 NSW electricity to 2020 – Transgrid 2008 projection



Notes to Figures 1 and 2

1. Consumption and supply projections include scheduled and non-scheduled electricity.
2. The Owen Inquiry did not consider energy growth projections beyond 2016/17, so consumption projections have been extrapolated to 2020 from 2016/17. Extrapolation of Owen Inquiry data uses annual growth of 1600 GWh per year (Table 2.1, Owen 2007). Extrapolation of the current Transgrid consumption projection uses the growth rate for native energy of 1.6% per year (Transgrid 2008, Table A 3.4).
3. Scheduled generation for the Owen Inquiry and the current Transgrid projection is taken as 85,100 GWh, the maximum output from NSW coal and gas generators (Owen 2007, page 2–10). No generation from the Snowy scheme is included in either projection.
4. Non-scheduled generation for the Owen Inquiry supply projection includes non-scheduled generation from Owen (2008 p. 12), and is assumed to grow in a linear manner. Non-scheduled generation for Transgrid uses the NIEIR report to NEMMCO (NIEIR 2008).

2.2 Potential for Distributed Energy to eliminate the energy shortfall

The projected energy shortfall does not include the potential for additional energy efficiency measures. Increasing end use energy efficiency and cogeneration options will reduce both electricity consumption and peak demand.

Figure 3 shows the effect of the energy efficiency and cogeneration options identified in this report (see *Section 4 Capacity options – distributed and renewable energy*) on electricity consumption, and of including additional renewable energy in the projected supply. This includes renewable energy generation which either exists already, or is expected as part of the 20% RET scheme).

There is the potential for an *excess* of electricity generation of more than 12,000 GWh in NSW in 2019/20, as shown in Figure 3, provided the following conditions are met:

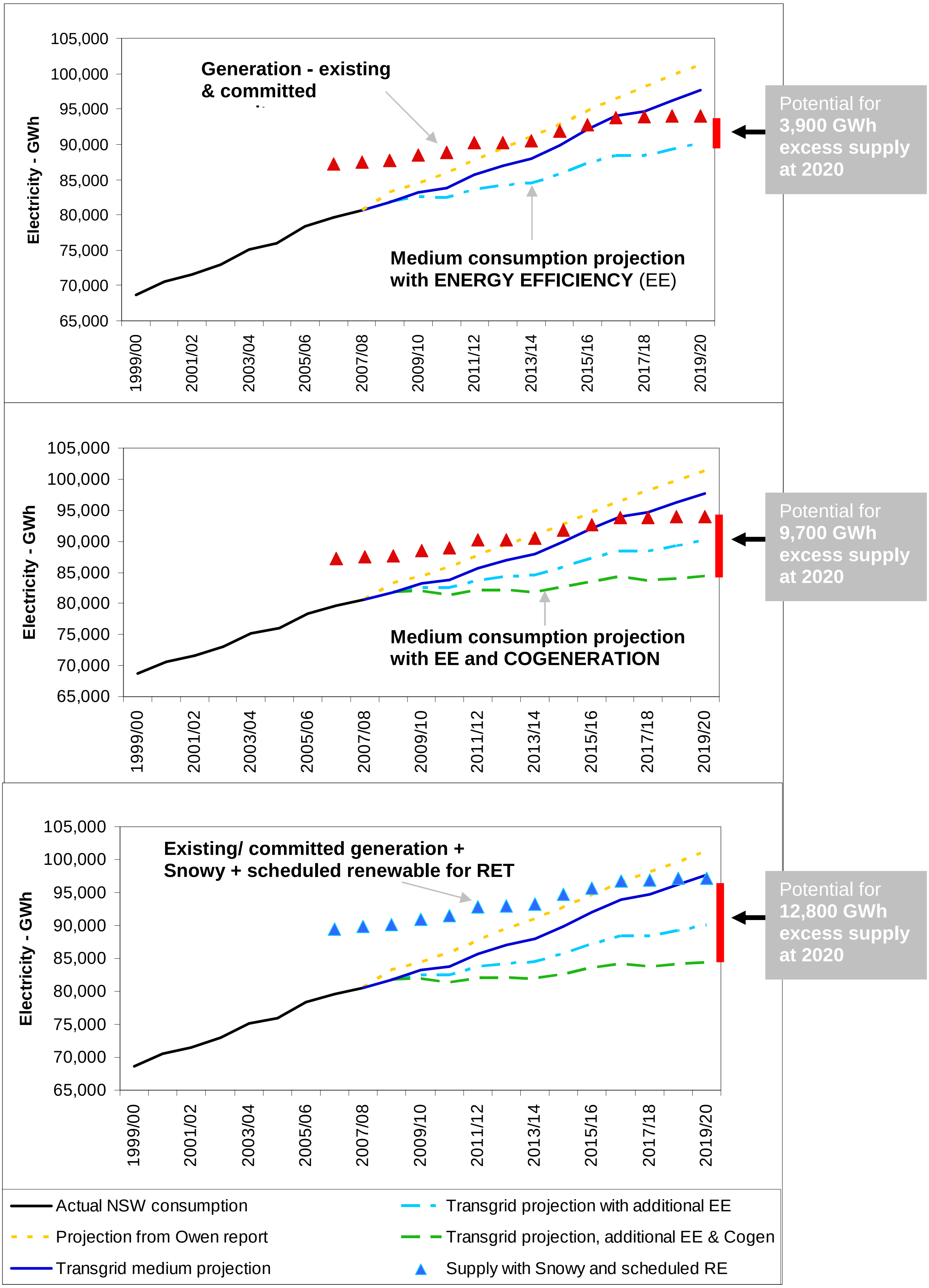
- energy efficiency measures described in *Table 3 NSW examples of energy efficiency potential* are adopted
- cogeneration as described in *Section 4.2* is put in place
- 50% of Snowy Mountains Scheme output is available to NSW and
- a proportion (12.5%) of the expected growth in scheduled national renewable energy growth occurs in NSW.

It can be seen that if the energy efficiency measures are adopted there is no energy shortfall. Instead there is the potential for an excess generation capacity of about 3,900 GWh in 2020.

If cogeneration options are also pursued, the potential supply could exceed consumption by approximately 9,700 GWh.

If the calculations include half of the renewable generation from the Snowy Mountains scheme and a proportion of the scheduled renewable electricity which is expected under the RETscheme, there is potential excess capacity energy of 12,800 GWh by 2020.

Figure 3 Potential to eliminate projected energy shortfall with Distributed Energy and renewable energy



2.3 Potential for renewable energy to eliminate the energy shortfall

The Owen Inquiry projection for NSW supply was very conservative, in that it took no account of generation from the Snowy Mountains Hydro-Electric Scheme. This section explores the effect of including some of the Snowy output, and a proportion of the increase in scheduled renewable generation which will result from the additional Renewable Energy Target (RET).

The total output from the Snowy scheme is estimated 4480 GWh (Connell Wagner 2007, p. 81). It is reasonable to assume that 50% of that will be available to NSW.

The main stimulus to additional renewable energy during the period to 2020 is the expanded national Mandatory Renewable Energy Target. This will require an additional 45,000 GWh by 2020.

The National Institute of Economic and Industry Research (NIEIR 2008) has undertaken work for the National Electricity Market to project the amount of non-scheduled generation likely within the NEM. Their projections for the breakdown of the revised target are shown in the table below.

Table 1 Source of renewable generation under new RET (NIEIR 2008)

	%	Electricity GWh
New scheduled renewable generation in the NEM	**16%**	**7,200**
New non-scheduled and exempted generation in the NEM	57%	25,650
New renewable generation in non- NEM networks	9%	4,050
Solar hot water heating	10%	4,500
Large hydro generators (generators which pre-dated RET)	7%	3,150
Other	1%	450
TOTAL		**45,000**

The NIEIR projection for non-scheduled generation is included in the supply projection in Figures 1–3.

However, a further 7,200 GWh of the revised RET is projected to come from scheduled renewable electricity. Even if NSW's share is only 12.5%[5], the energy available over the year would increase by 900 GWh by 2020.

This additional capacity from scheduled renewable energy and the Snowy scheme is *not* included in the analysis in this report, other than in this section.

[5] The NIEIR projection shows 25% of non-scheduled generation to meet the revised RET occurring in NSW, so 12.5% is likely to be a conservative estimate of the NSW share of new scheduled RET generation.

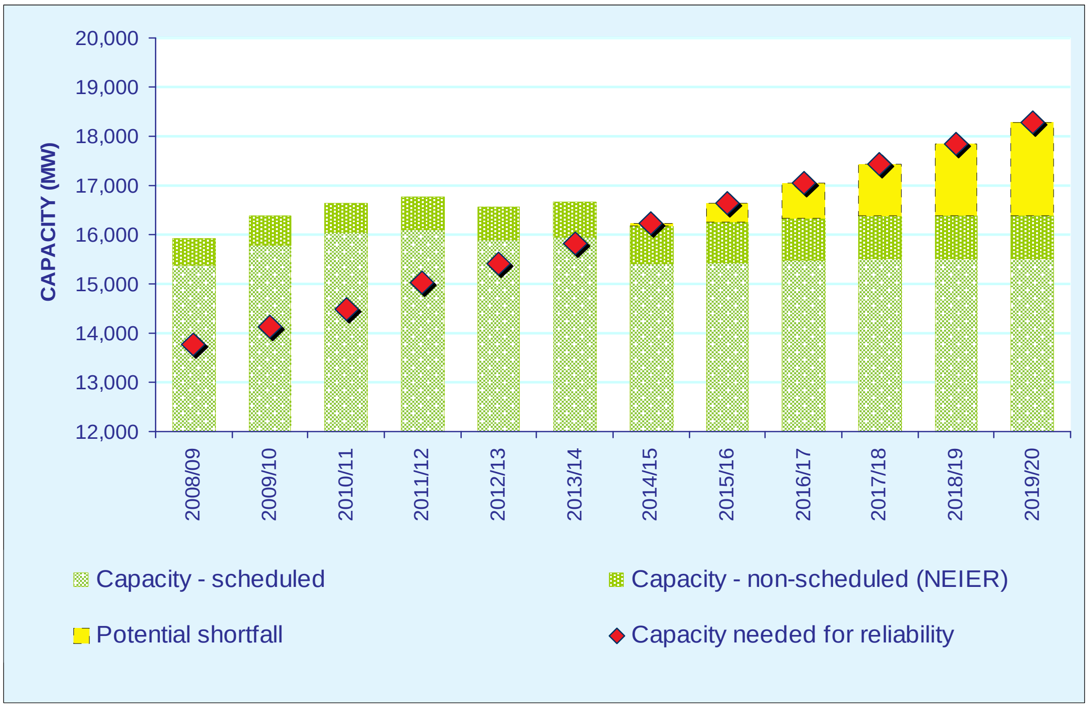
3 Demand and capacity projections for NSW

3.1 Current projection and shortfall

The National Electricity Market Management Company (NEMMCO) publish a yearly Statement of Opportunities (SOO) identifying forecasts and potential shortfalls (and therefore market opportunities) within the national electricity market. The SOO contains estimates of the maximum winter and summer demand by state for low, medium, and high growth scenarios, the required generation capacity for reliability, and any projected shortfalls. In addition, NEMMCO publishes a calculator which can be used to gain further insight into specific projections (NEMMCO 2008b). Only the medium growth scenario is considered in this report, as under the current economic conditions this is likely to be revised downwards in any case.

Figure 4 shows the current NEMMCO projection for the capacity needed for reliability[6] at maximum demand in NSW to 2020, at the 10% POE level[7]. As may be seen, there is a potential shortfall of 390 MW in 2014/15, rising to 1,900 MW in 2019/20. The projection is conservative, assuming coincident maximum demand in all states.

Figure 4 NSW capacity needed for reliability, maximum summer demand to 2020



Note: *Figure 4 shows the NEMMCO 2008 projection modified to include non-scheduled demand and capacity (based on 10% probability of exceedance-POE).*

The current NEMMCO projections include only scheduled generation and demand. As non-scheduled generation will play an increasing role in Australia's electricity supply, these projections are modified to include non-scheduled demand and generation. Demand projections are also extrapolated to 2019/20, using an annual growth rate of 2.4% (NEMMCO 2008a, p. 3-43).

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[6] Capacity for reliability takes into account the maximum demand at 10% PoE and the minimum reserve levels for the region, so is slightly above the minimum reserve level.

[7] The projection for 'capacity needed for reliability' has been taken from the NEMMCO calculator, after replacing the figures for scheduled demand with the figures for native demand in Table 3.29 of the 2008 SOO (NEMMCO 2008a).

In NSW, projected maximum summer demand in 2008/9 at the 10% POE level was approximately 700 MW greater than winter peak demand at the same POE, and by 2017/18 is nearly 1,900 MW greater. This report therefore uses summer peak demand as this is expected to be the dominant driver of investment needs.

3.2 Non-scheduled generation included in projection

The non-scheduled generation used to modify the NEMMCO projection is taken from NIEIR (2008), and tabulated below. The proportion of firm capacity allowed at 10% POE is shown in each case. Only 5% of wind capacity is allowed, as prescribed in NEMMCO (2008, p. 3-60, Table 3.48). Note that only three years are shown below, but all intervening years are used in the projection, as given in the NIEIR data.

Table 2 Non-scheduled generation used to modify the NEMMCO projection

TOTAL CAPACITY (MW)				
		2008–09	**2016–17**	**2019–20**
Biomass		**165**	**269**	**289**
Wind		**16**	**1,948**	**1,948**
Hydro		**203**	**217**	**221**
Gas		**222**	**317**	**328**
Fuel oil		**50**	**50**	**50**
Coal		**11**	**11**	**11**
TOTAL		**667**	**2,812**	**2,847**
FIRM CAPACITY AT 10% POE				
	%	**2008–09**	**2016–17**	**2019–20**
Biomass	90%	165	269	289
Wind	5%	1	97	97
Hydro	50%	102	109	111
Gas	95%	222	317	328
Fuel oil	90%	50	50	50
Coal	90%	11	11	11
TOTAL		**550**	**853**	**886**
GENERATION (GWh per year)				
	Capacity factor	**2008-09**	**2016-17**	**2019-20**
Biomass	56%	665	1,315	1,421
Wind	30%	29	5,107	5,107
Hydro	20%	309	378	381
Gas	65%	1,318	1,817	1,875
Fuel oil	0%	0	0	0
Coal	90%	81	81	81
TOTAL		2,403	8,700	8,866

***Notes to* Table 2**

1. Total capacity and generation from NIEIR (2008, pp. 28–29 Tables B1 and B2)
2. The availability assumptions used to derive capacity at 10% POE are shown. The 5% for wind is taken from NEMMCO (2008, p. 3-60) which may be unduly conservative.

4 Capacity options – distributed and renewable energy

Distributed Energy involves energy solutions close to where the energy is used, and has cost and environmental advantages compared to centralised generation. Transmission losses are avoided, which average about 4% of generated electricity in NSW. The increased use of Distributed Energy may make it possible to defer or avoid altogether much of the augmentation of the high voltage transmission network. Distributed generation also offers the potential to utilise heat as well as electricity from power generation, which significantly increases the overall efficiency of the system.

Distributed generation includes any electricity generators that connect to the distribution network rather than the high-voltage electricity transmission network. Distributed generation ranges from domestic-scale photovoltaic systems of one or two kilowatts to gas combined cycle cogeneration of a hundred megawatts or more at industrial sites.

Distributed generation includes:

- small-scale plants that supply electricity to buildings, industrial sites or communities. These may sell surplus electricity back into a distribution network.
- 'microgeneration', for example, small installations of solar panels, or biomass burners, or small-scale cogeneration systems that supply one building or a small community.
- large cogeneration plants, supplying a number of buildings, for example, a CBD or a large industrial complex. Electricity may be fed into the distribution system while heat is used locally.
- wind farms located close to load. Until the end of 2003 all wind farms in Australia fed into the distribution network, rather than the high voltage transmission network, but this has changed as projects have got bigger.

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4.1 Energy efficiency

There is considerable scope for increased energy efficiency in NSW. The examples detailed in Table 3 total 1000 MW, with an annual energy reduction of 7,000 GWh. These include commercial lighting retrofits (from CEC 2007), residential hot water systems (from SEDA 2002), and industrial energy efficiency improvements which pay for themselves within four years (from Energetics 2004).

The NSW Government recently announced an Energy Savings Scheme which aims to achieve annual electricity consumption savings of 4% by 2014 and then maintain savings at that level until 2020. This is equal to saving 3,200 GWh per year from 2014 to 2020 Tebbutt 2009) – approximately half of the efficiency potential identified in this report. The energy efficiency identified here equals approximately 7,000 GWh – equivalent to an 8% target by 2020; at 2014 it would save 4,000 GWh, very close to the ESS 2014 target.

There is considerable scope for further energy efficiency in NSW which has not been included in this report. For example, the Australian Emission Reductions Model (MMA and CI 2008) allows the user to nominate the time period in which their investment in energy efficiency measures would be recouped. Setting the payback period at five years for residential efficiency and two years for commercial and industrial energy efficiency, the model estimates that the potential exists for increased energy efficiency to reduce electricity consumption by more than 50,000 GWh Australia wide. Assuming that NSW's share would be 30%, this equates to potential for nearly 10,000 GWh in annual electricity savings.

Table 3 NSW examples of energy efficiency potential

	Energy generation GWh	Capacity equivalent MW	Reference
Commercial lighting	3095	353	Derived from CEC (2007) Clean energy potential in NSW
Residential hot water (replace electric with gas)	790	300	SEDA (2002) Distributed Energy Solutions
Residential energy efficiency	164	75	SEDA (2002) Distributed Energy Solutions
Industrial energy efficiency	2989	341	Derived from Energetics (2004). Energy Efficiency Improvement Potential Case Studies – Industrial Sector.
TOTAL	**7038 GWh**	**1069 MW**	

Notes to Table 3

1. The energy potential (GWh) for improved efficiency in commercial lighting in NSW is taken directly from CEC (2007). The capacity (MW) equivalent assumes 100% capacity contribution at maximum summer load. This is likely to be an underestimate as a high proportion of commercial lighting load is concentrated during office hours. The measure would involve major refurbishments to achieve a lighting efficiency improvement of 7.5 W/m^2, approximately 35%.

2. In 2006, 66% of NSW houses still used electric hot water heaters (ABS 2006).

3. Only half the potential increase in residential energy efficiency noted in SEDA (2002) has been included, as improved residential lighting is included in the NIEIR projections.

4. Energetics (2004) noted the potential for 33.6 PJ of electricity savings from implementing industrial energy efficiency with a cumulative payback of less than four years. A proportion of this has been allocated to NSW according to its share of NEM consumption (32%). The capacity equivalent is 13.6% of maximum summer demand from NSW industrial customers (Transgrid 2008). Note that this is may be an underestimate, as it assumes that the industrial load is spread evenly rather than following the peak demand profile.

5. Table contains minor data revisions to an earlier version.

Table 4 Australia wide energy efficiency potential

(from the Australian Emission Reduction Model)

	Greenhouse gas savings million tonnes	**Cumulative capital expenditure** AU$ million	**Annual electricity savings** GWh	**Annual gas savings** PJ
Residential	38.7	$9,446	31,505	7
Industrial	25.9	$1,652	10,873	71
Commercial	16.3	$731	8,067	2
Overall total	**81.0**	**$11,829**	**50,445**	**80**

Notes to

Table 4

1. Residential energy efficiency includes measures with simple payback of up to 5 years.
2. Industrial and commercial efficiency include measures with simple payback of up to 2 years.

4.2 Cogeneration

The Sustainable Energy Development Authority 2002 report (SEDA 2002) into Distributed Energy solutions identified 1845 MW of cogeneration potential. Some of these projects are in advanced planning stages, so are included in the committed generation projections. Only 730 MW of cogeneration has been included in this report, comprised of 400 MW of small industrial cogeneration (SEDA 2002), and the 330 MW of cogeneration proposed in the City of Sydney's Sustainable Sydney 2030 Strategy (City of Sydney 2008). This is likely to be an underestimate of the potential for cogeneration in the state. For example, the Australian Emissions Reductions Model identifies potential for 3,400 MW Australia wide by 2020, which would mean that NSW's share would be approximately 1100 MW (Climate Institute and MMA 2008).

4.3 Demand Side Response

Demand Side Response (DSR) is the ability for electricity consumers to reduce loads at times of peak price or peak demand by temporarily switching appliances and plant off, or by switching electrical loads to standby generators.

Peak load management includes individual businesses or consumers responding to high pricing, which requires a means to communicate the price changes to the user. Increased penetration of time-of-use metering, and various communication devices to alert customers to peak pricing, are likely to induce a response. This general approach has not been included in this report as it is difficult to obtain accurate estimates of costs and benefits.

However, DSR can also be formally managed and sold as capacity in the system, so that customers are paid to reduce demand from the grid at certain times for short periods. This process is termed "aggregation" and usually involves a payment for being available and willing to reduce demand and a further payment for successfully responding when requested.

Demand aggregators are companies which act as mediators, bringing together a significant number of customers and forming contracts with the electricity retailers, networks and NEMMCO, to purchase load shedding on their behalf.

One demand aggregator, Energy Response, made a submission to the Owen Inquiry (Energy Response 2007), stating that they were able to guarantee 300 MW of DSR in NSW within a period of hours. Energy Response has sold 125 MW of firm reserve capacity to the NEM, and is currently providing 50MW of firm DSR to reduce summer peaks on the Transgrid system. Energy Response has indicated they could reliably supply well in excess of 1000 MW of DSR by 2020 (Energy Response 2009).

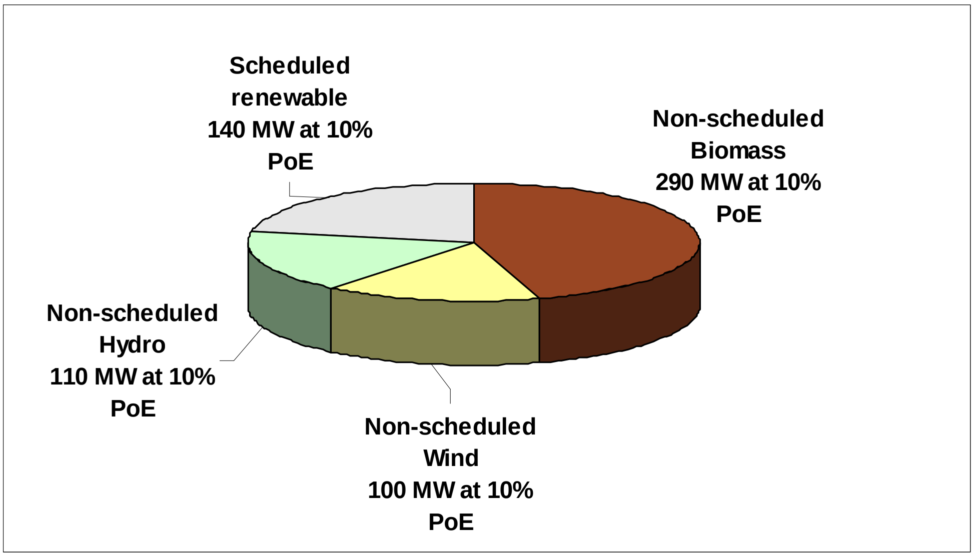
4.4 Renewable energy

The additional non-scheduled renewable energy located in NSW, and the assumptions for capacity at 10% POE, are detailed in *Table 2 Non-scheduled generation used to modify the NEMMCO projection* and *Table 1 Source of renewable generation under* *new RET (NIEIR 2008).* These are included in the 'existing and planned' capacity, so are treated as business as usual.

There will also be growth in scheduled renewable generation, a proportion of which will be located in NSW (see *Table 1 Source of renewable generation under new RET (*NIEIR 2008)). If it is assumed that all of this additional supply comes from wind power, then this growth in renewable energy will contribute a further 15MW firm capacity at 10% POE. The intermittent nature of wind generation means this is the most conservative assessment, as only 5% of nameplate capacity is included. Other types of renewable generation (for example biomass or geothermal) are likely to make a higher contribution at peak times.

Total capacities of scheduled and non-scheduled generation, and capacities at 10% POE, are shown in Figure 5. Only the non-scheduled contribution has been included in the analysis in this report.

Figure 5 Contribution of renewable energy by technology at 10% POE



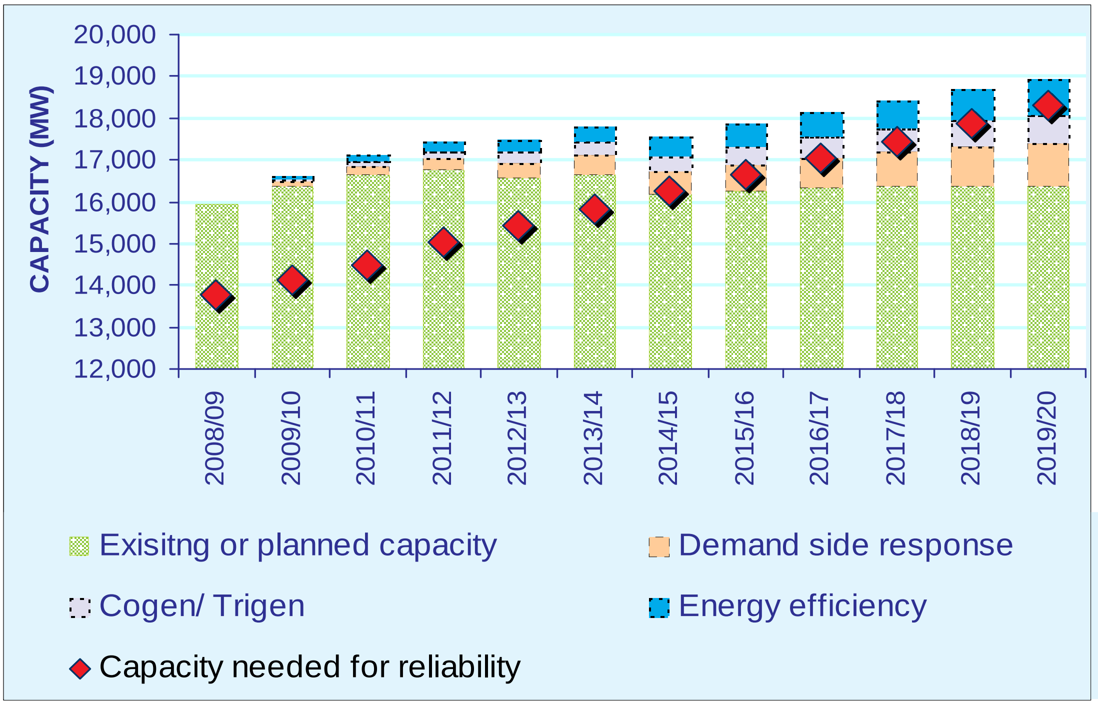
4.5 *Can Distributed Energy meet the demand shortfall?*

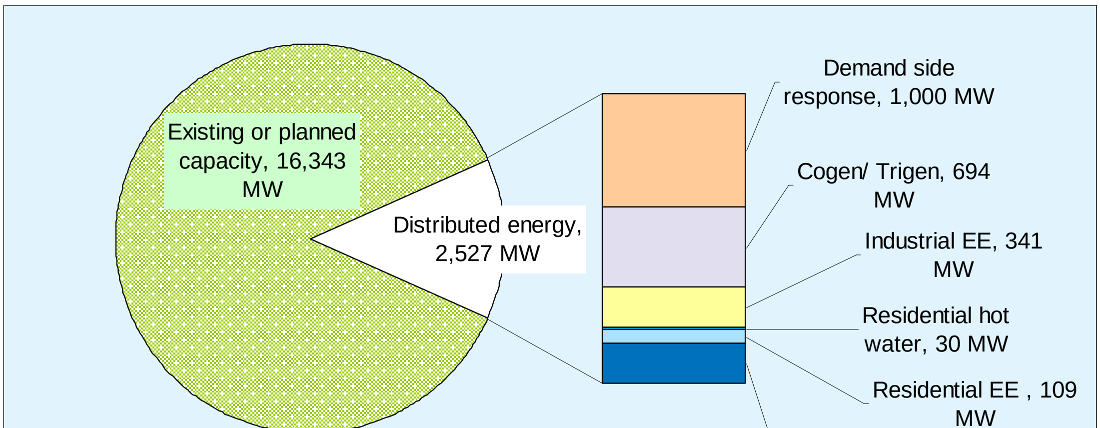
According to the official NEMMCO projections, the generation capacity needed to reliably supply the NSW maximum summer demand in 2020 is 18,286 MW (NEMMCO 2008b, projected to 2020). Existing and currently committed generation is projected to provide 16,343 MW in 2020 (including both scheduled and non-scheduled generation). This gives a projected potential shortfall of nearly 2000 MW.

The Distributed Energy options identified in this report, primarily cogeneration, energy efficiency, and demand side response could supply nearly 3,400 MW by 2020, well in excess of the required capacity increase.

Figure 6 shows the projected capacity requirements, and the potential supply including Distributed Energy. The pie chart shows details of the Distributed Energy options at 2020. The options identified, which have been estimated conservatively, can provide a wide buffer to the required capacity.

Figure 6 NSW actual and required capacity to 2020, with Distributed Energy (maximum summer demand at 10% POE)





2020 potential supply at 10% POE: 18,870 MW.
Capacity needed: 18,286 MW

5 Capacity options – centralised generation

5.1 Gas turbines (excluding cogeneration)

Gas turbines come in two main configurations, open cycle (OCGT) and combined cycle (CCGT). Both have shorter development lead times than coal fired generation, and are less capital intensive to build, although natural gas is a more expensive fuel than coal.

Combined cycle turbines use waste heat from the turbine to produce steam to drive a second generator. This gives a considerable efficiency increase, with the result that CCGTs have emissions of approximately 0.35 tonnes CO_2 per MWh, compared to current coal generation of about 0.9 tonnes CO_2 per MWh.

The NEMMCO projections for NSW energy supply assume any shortfall will be met by a mixture of open cycle (OCGT) and combined cycle gas turbines. The projection includes 400 MW of CCGT coming online in 2014/15, 400 CCGT coming online in 2117/18, and 150 MW of OCGT coming online in 2016/17 (NEMMCO 2008b, NSW summer generation worksheet).[8]

5.2 Coal

The main options for coal fired generation with improved greenhouse performance relative to current generation are ultra-supercritical pulverised coal and integrated coal gasification combined cycle, with the second of these options potentially operating in combination with carbon capture and storage (CCS). However, CCS is unlikely to be available before 2020 (Connell Wagner 2007, p. 82), so has not been considered here.

Ultra supercritical refers to the temperature and pressure of the steam, as above a critical temperature and pressure, liquid and gaseous water can co-exist in equilibrium. There is an efficiency gain of about 6–8% compared to sub-critical generation, resulting in an emissions reduction of up to 20%. It is assumed that dry cooling would be used in any new developments, giving an average emission intensity of 0.84 tonnes CO_2/ MWh (Connell Wagner 2007, p. 13).

Integrated gasification combined cycle coal fired power offers a further efficiency gain and emissions reduction, but has somewhat higher costs and additional project risks. If CCS becomes available it could be retrofitted to IGCC power stations. The average emissions of IGCC coal generation without CCS are 0.81 tonnes CO_2 /MWh (Connell Wagner 2007, p. 21).

[8] The NEMMCO calculator nominates blocks of 380 MW, which are equivalent to 400 MW nameplate after allowing for a 90% availability.

6 Cost comparison of capacity options

The costs of various options for meeting the potential capacity shortfall are shown in Table 5, along with the greenhouse emissions per MWh for each option. The total cost per MWh given is an estimate of the amortised capital costs over the life of the equipment, plus variable costs (fuel and maintenance), fixed costs based on an estimate of annual generation, and the associated network costs.

Table 5 Cost comparison of capacity options

	Capital cost $m/MW	Capital Life years	Variable cost $/MWh	Associated network cost $m/MW/yr	Total amortised cost $/MWh	Greenhouse emissions t CO_2e/MWh	NOTE
Energy efficiency							
Industrial	$1.7	10	nil	nil	$32	0.0	1
Commercial lighting	$1.6	10	nil	nil	$18	0.0	3
Residential – general	$1.0	10	nil	nil	$46	0.0	2
Residential – replace electric water heating with gas	$0.6	10	$1	nil	$35	0.2	2
Demand Side Response	$0.1	10	$1,000	nil	$1,093	n/a	4
Gas cogeneration	$1.5	20	$33	$0.10	$68	0.4	2
Renewable energy							
Wind generation	$2.2	25	$5	$0.10	$117	0.0	5
Hydro	$2.1	25	$3	$0.10	$80	0.0	5
Bioenergy	$2.9	25	$60	$0.10	$123	0.0	5
Fossil fuel generation							
Ultra super critical coal	$1.7	35	$24	$0.30	$85	0.84	6
IGCC coal	$2.1	35	$25	$0.30	$92	0.80	6
Gas combined cycle	$1.2	30	$38	$0.20	$77	0.4	7
Gas open cycle	$0.9	30	$40	$0.20	$114	0.7	8

Notes to Table 5

1. Industrial energy efficiency: the capital cost Australia wide of achieving 9,340 GWh reduction in electricity consumption is $1817 million (Energetics 2004, p. 66). This achieves a 13.6% reduction in electricity use compared to business as usual. The overall cost to NSW has been calculated according to the proportion of NEM consumption occurring in the state. The NSW cost is then divided by the assumed capacity reduction, calculated as 13.6% of maximum industrial demand at 10% PoE
2. Costs from SEDA (2002)
3. Costs derived from the average cost of lighting measures in EMET (2004), Appendix 2.
4. Energy Response (2009)
5. Wind generation, hydro and bioenergy: costs from MMA and Climate Institute (2008). Capital cost uses an annual deflator applied for 5 years, to give an average for the period. Costs for bioenergy exclude wet waste, which are lower. Lifetime is from MMA (2007).
6. Coal (ultra supercritical, dry cooled) and coal IGCC: costs are the average of the range given in Connell Wagner (2007). Capital lifetime is from MMA (2007).
7. Combined cycle gas turbine (CCGT): costs from MMA (2007). Lead time, capacity factor, and emissions factor taken from SEDA (2002).

Only the network costs associated with peak growth are included, as maintenance, and some growth costs will be incurred regardless of the generation type. These costs are discussed in *Section 7.1 Calculating cost and greenhouse emissions – method*.

The amortised capital cost of existing generation and existing networks is not included as it is assumed this would be the same for all options.

A cost of $20 per MWh is used for the variable cost of existing generation, which becomes a saving when existing generation is displaced. This only occurs when energy efficiency displacement is greater than projected growth, as the model is constructed to assume that existing generation takes precedence over new generation.

7 Meeting the shortfall – scenarios

Five alternative scenarios to address the projected shortfall in peak capacity to 2020 have been modelled. There is a coal scenario, which broadly corresponds to the Owen Inquiry suggested planning[9], a gas scenario which corresponds to the one shown in the NEMMCO 2008 statement of opportunities, and three Distributed Energy scenarios, the last of which includes reducing coal generation capacity by 1000 MW.

None of the three Distributed Energy scenarios are ambitious in scope, as they use conservative estimates of the potential capacity for energy efficiency and distributed generation.

The scenarios are:

Scenario A. **Coal**: an additional 1000 MW coal fired power station comes online in 2017/18, followed by two 500 MW open cycle gas turbines in 2018/19, and 2019/20. This scenario follows the findings of the Owen Inquiry.

Scenario B. **Gas**: a combination of open cycle (OCGT) and combined cycle gas turbines is used to meet capacity shortfalls as assumed in the 2008 NEMMCO projections.

Scenario C. **Cogeneration and DSR**: the shortfall in capacity is met by a combination of cogeneration and demand side response. A small amount of industrial energy efficiency is included as the modest amounts of cogeneration and DSR which have been included were not quite sufficient to meet the entire capacity shortfall.

Scenario D. **Energy Efficiency and DSR**: the shortfall in capacity is met by a combination of energy efficiency and demand side response.

Scenario E. **Combined Distributed Energy**: the shortfall in capacity is met by a combination of energy efficiency, cogeneration, and demand side response, and 1000 MW coal fired generation capacity is retired in 2014/15.

All five are shown graphically in Figure 7.

7.1 Calculating cost and greenhouse emissions – method

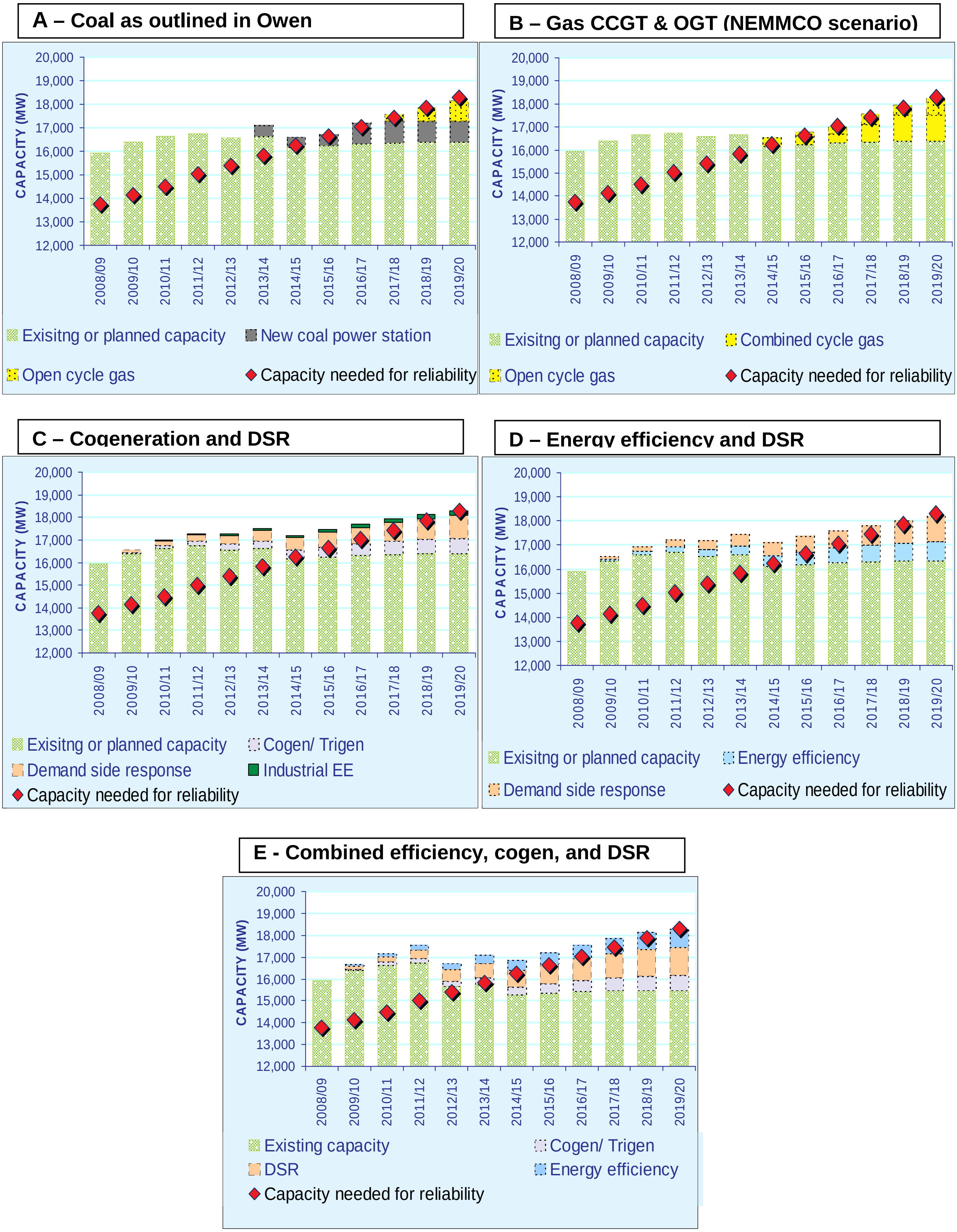
The cost calculations include: amortised capital costs, variable costs for electricity generation, network augmentation costs, and the variable costs from existing or planned generation capacity. The derivation of each is outlined below. No element of capital cost for existing or committed generation capacity is included. It is also important to note that this analysis does not take into account any carbon cost. If the value of avoided greenhouse gas emissions were to be included, then the Distributed Energy scenarios would become even more attractive

Amortised capital cost

The amortised cost of capital is calculated in this analysis using an internal rate of return of 10% and the lifetime of the equipment. Lifetime has been taken as 10 years for energy efficiency equipment, and between 20 and 35 years for generation plant.

[9] The Owen Inquiry suggested an earlier date to come online, and a greater energy shortfall.

Figure 7 Scenarios included in the analysis



Network augmentation costs

Network augmentation costs are a crucial element in any robust analysis of electricity supply costs. Whenever power stations are built there is some level of associated network investment in order to deliver power to customers. If centralised generation capacity can be avoided through investment in Distributed Energy, then this will also avoid some level of transmission and distributions network capital expenditure.

At present, the cost of planned network investment is very high, with about $17 billion in network capital expenditure planned for the period 2009 to 2014.

Estimating network capital expenditure that is specifically related to growth is difficult both because of its local nature and because of a lack of relevant available data. However, the following table provides a reasonable estimate using the data which is currently available. About $7 billion, or 40%, of the planned network expenditure is estimated to be growth related.

Table 6 Growth-related network capital expenditure 2009–2014 ($million)

Network business	Growth related capital expenditure ($m) 2009–2014	Growth related capital expenditure ($m) Per annum	Peak demand growth (MW) 2009–2014	Peak demand growth (MW) Per annum	Growth CapEx per MW ($m/MW)	Notes
Country Energy	$1,417	$283	323	81	$3.49	1
Energy Australia	$3,181	$636	689	172	$3.70	2
Integral Energy	$1,346	$269	643	161	$1.67	3
Distribution Total	$5,944	$1,188	1655	414	$2.87	
Transgrid (transmission)	$1,951	$390	1740	435	$0.90	4
Total	**$7,589**	**$ 1,518**			**$3.77**	5

Notes to Table 6

1. AER, New South Wales Draft distribution determination 2009–10 to 2013–14. p.135, p.85
2. AER, New South Wales Draft distribution determination 2009–10 to 2013–14, p. 136, p.88.
3. AER, New South Wales Draft distribution determination 2009–10 to 2013–14. p.137, p. 91
4. AER, Transgrid Draft Transmission determination 2009–10 to 2013–14, p. 16, p.34 (10% POE)
5. Peak Demand cannot be totalled as Transgrid's peak load includes that of the distributors

Based on an average growth-related network cost of $3.77 million per MW and a weighted average cost of capital of 8.78% per annum (AER 2009, p. 237), the annualised capital cost is $0.33m per MW per year. Based on a uniform depreciation of 2.5% per annum over 40 years, this cost of depreciation is $0.093m per MW per annum. This amounts to a total annualised cost of growth-related network investment of $0.42 million per MW per annum. However, recognising that network costs are very location dependent, our analysis has adopted a lower, more conservative value of $0.3 million per MW per year for the default network augmentation cost to meet growth in peak demand.

Centralised supply and Distributed Energy options have each been allocated a default network augmentation cost, which is used for the portion of demand growth met by that option. The network augmentation costs used are given in Table 7 below. For example, energy efficiency and demand side response have augmentation costs of zero, as meeting the growth in peak demand with these options does not require increased network capacity.

For each scenario, the proportion of demand growth that is not met by Distributed Energy options included is instead met by existing or new centralised supply capacity. For this proportion, a default maximum augmentation cost of $0.3 million per MW per year is applied for new centralised supply capacity.

Table 7 Network augmentation costs for demand growth, by technology

Technology	Network augmentation cost ($ per MW per year)	Notes
Estimated growth related network costs	$ 0.42 million	See Table 6
Default cost for centralised supply	$ 0.3 million	Discounted from estimated growth related network costs, to ensure assumptions are conservative.
Coal generation	$ 0.3 million	Coal fired power is the default option for centralised supply
Combined cycle gas turbines	$ 0.2 million	Combined cycle and open cycle gas turbines are attributed a lower network capital cost as they are generally located closer to the point of customer demand.
Open cycle gas turbines	$ 0.2 million	
Cogeneration	$ 0.1 million	Cogeneration is attributed a lower network capital cost than gas turbines as it generates electricity at the point of end use.
Energy efficiency	$ 0	Energy efficiency and demand side response are attributed a zero network capital cost as by definition they eliminate the need for supply for that amount of end use. (N.B. the cost of facilitating these options is not zero and has been considered in the analysis as indicated in Table 5.)
Demand side response	$ 0	

The above default values are estimates that have been adopted due to the absence of more rigorous data. Further analysis of actual avoidable networks costs is highly desirable, but beyond the scope of this report.

Variable cost for existing or planned generation

Generation from existing or planned generation has been costed at $20 per MWh, so no account has been taken of dispatch order. Where energy efficiency beyond the forecast growth in consumption is installed, this decreases the amount of electricity generation required, resulting of savings at the rate of $20 per MWh. This may underestimate the savings from energy efficiency, as the highest-cost electricity will generally be the first to be removed from the market.

Variable cost for new supply

Where projected electricity consumption exceeds the generation from current and planned consumption, which first occurs in 2017/18 (see *Figure 2 NSW electricity to 2020 – Transgrid 2008 projection*), the variable cost of electricity from the new supply is included. Generation is allocated between new supply options in proportion to their capacity factors.

Where maximum summer demand at 10% POE exceeds current generation capacity but total consumption does not exceed total supply, generation equivalent to 1% of the time (88 hours per year) is allocated between the new supply options, and this variable cost included.

Greenhouse emissions

Greenhouse emissions are calculated using the pool factor of 0.9 tonnes per MWh for existing or planned generation, and using the technology-specific emission factors for new generation given in *Table 5 Cost comparison of capacity options*.

7.2 Cost and greenhouse comparison – results

The cumulative cost of each scenario from now to 2020 is shown in Figure 8.

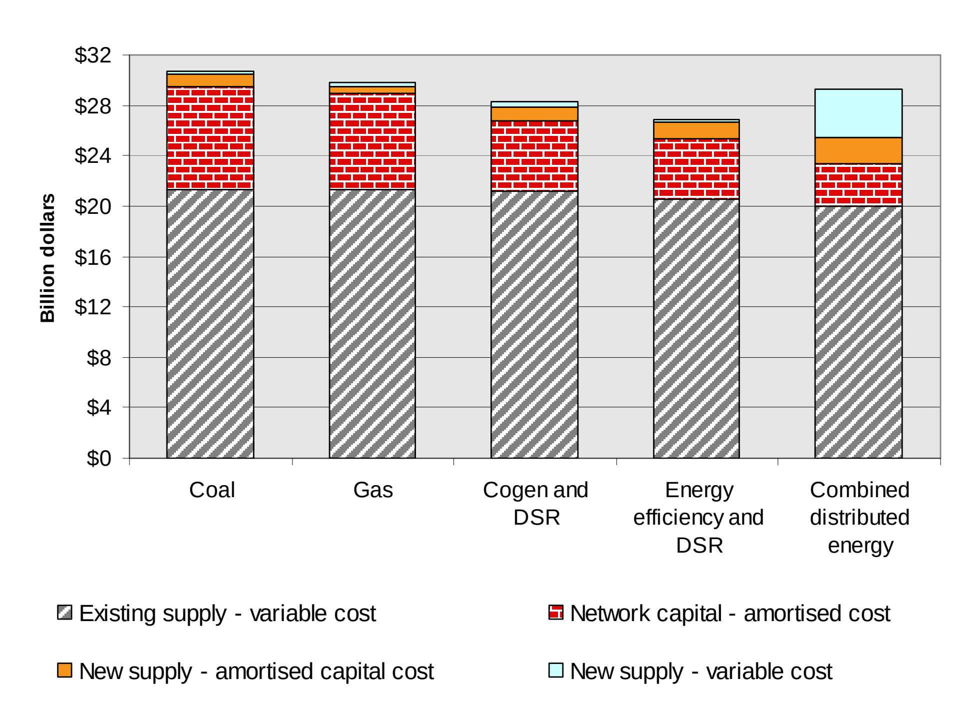
The most expensive scenario is the coal scenario, building a new coal fired power station, which is closest to the recommendations of the Owen Inquiry. The coal scenario comes in at $30.7 billion. This is followed by the NEMMCO scenario (closed and open cycle gas) at $29.8 billion. The three Distributed Energy scenarios are all cheaper, ranging from $26.8 billion to $28.3 billion.

Costs in this analysis are dominated by the variable costs of existing generation. While the recovery of past fixed capital costs in electricity networks are greater, they have not been included in this analysis as they are a “sunk” cost that cannot be altered.

After the costs of existing generation, the next largest item is the cost for new network augmentation to cater for the projected rise in peak summer demand. Note that this only includes the proportion of network costs related to peak demand growth, and does not include new capital expenditure for asset replacement, reliability improvement, or maintenance.

The amortised capital cost for the new supply and efficiency options is lowest in the NEMMCO scenario, closed and open cycle gas generation. The higher capital cost for energy efficiency is partly accounted for because a shorter capital life is assigned, 10 years compared to 20 for cogeneration, 30 years for large-scale closed cycle gas, and 35 years for coal fired power. This is a conservative approach, as the capital life for many energy efficiency measures will in fact be longer.

Figure 8 Cumulative costs to 2020, NSW energy supply

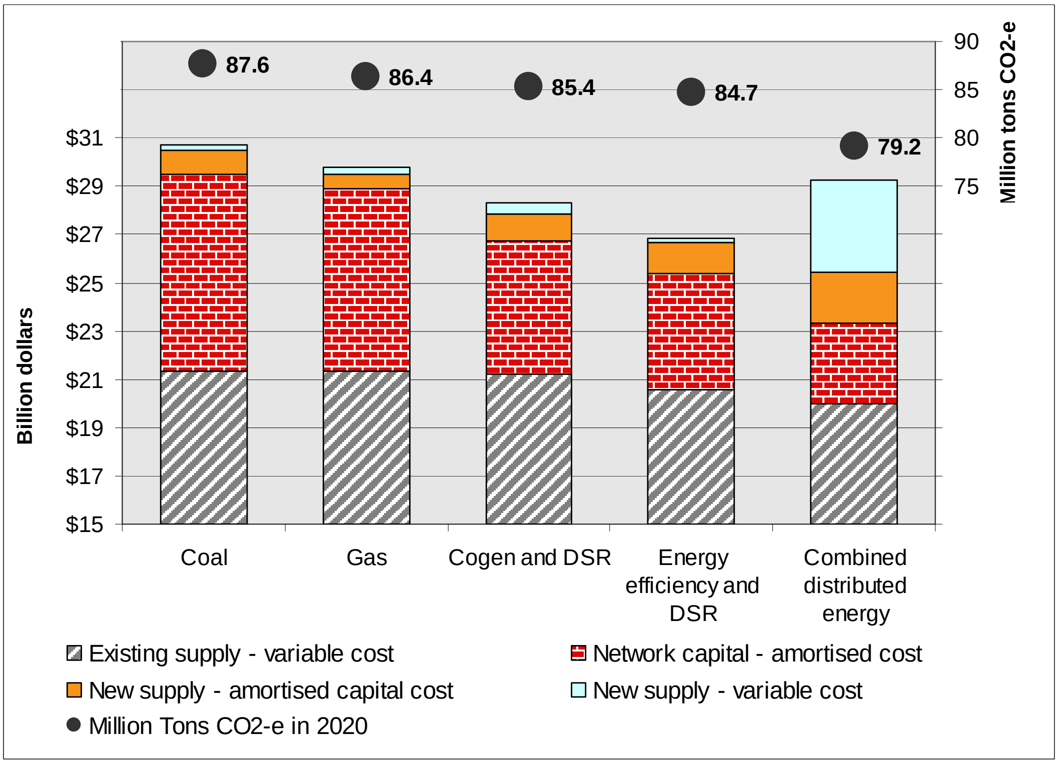


Greenhouse emissions and costs are shown in Figure 8 and Figure 9. Using all the Distributed Energy options identified in this case study in combination with retiring 1000 MW of coal fired generation has the lowest greenhouse emissions, with an annual saving by 2020 of 7.2 million tonnes of carbon dioxide compared to the gas CCGT scenario, and 8.4 million tonnes of carbon dioxide compared to installing a new coal fired power station.

While this option is more expensive than the efficiency and demand side response without cogeneration, it still saves $0.5 billion compared to the NEMMCO scenario, which may be considered business as usual. It also reduces greenhouse emissions by 8% compared to the NEMMCO scenario.

The scenario involving efficiency, DSR, cogeneration and closing a coal fired power station saves $1.5 billion compared to building an additional coal fired power station.

Figure 9 Cumulative costs to 2020 and 2020 greenhouse emissions



7.3 *Demand growth – results*

The power station capacities needed for reliability under the coal and the NEMMCO scenarios remain unchanged, as they are assumed to be the same as the projections from the NEMMCO 2008 SOO (this has been modified to include both scheduled and non-scheduled generation, as described in *Section 3.1 Current projection and shortfall*).

However, in the Distributed Energy scenarios (including energy efficiency and DSR), peak demand is reduced, so the capacity needed for reliability is also reduced. Figure 10 shows the capacity needed for reliability in each scenario, and Figure 11 shows the annual growth in that capacity.

The average growth rate[10] over the ten-year period varies from 2.6% in the NEMMCO projection to 1.5% per year in the scenario with energy efficiency, cogeneration and demand side response. The average growth rate for the ten years is shown in Table 8.

[10] Strictly speaking this is the growth in the capacity needed for reliability, rather than the growth in demand.

Table 8 Average growth rate in NSW capacity for reliability, 2011/12–2019/20

	NEMMCO	Coal	Cogen, DSR and EE	EE & DSR	Cogen and DSR
Average growth rate	2.6%	2.6%	2.0%,	1.7%	1.5%

Figure 10 Capacity needed for reliability by scenario

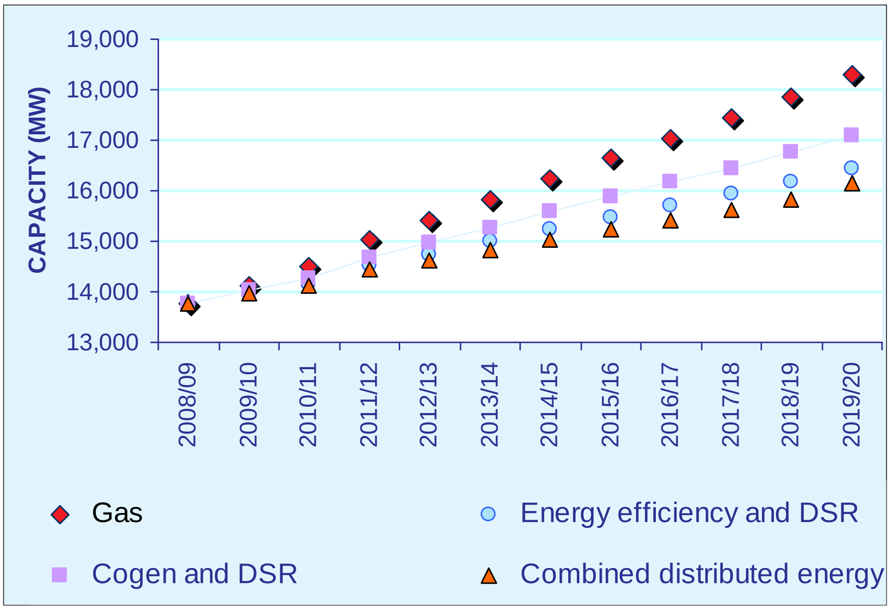
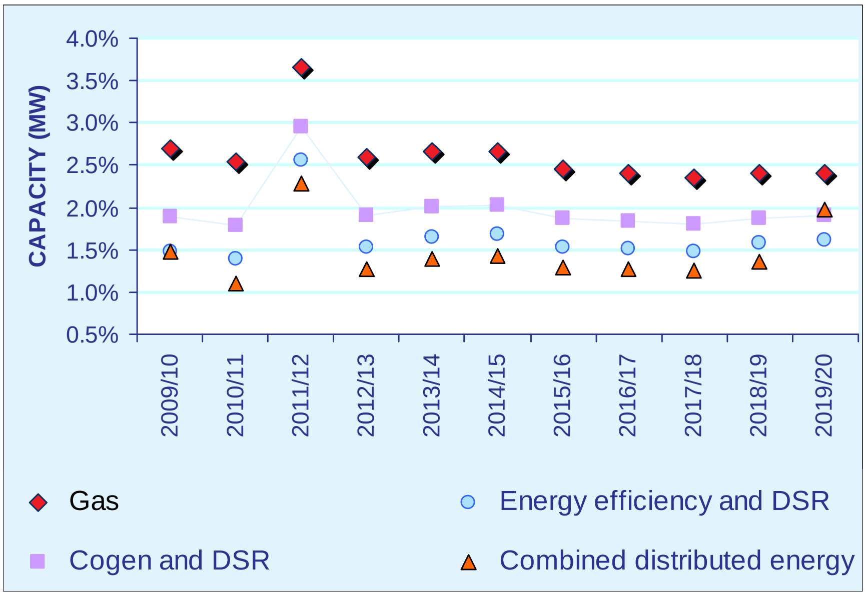


Figure 11 Demand growth by scenario



8 Policy initiatives to support Distributed Energy

The preceding analysis indicates that each of the three Distributed Energy scenarios delivers both significantly lower cost for consumers and significantly lower greenhouse gas emissions than the centralised "business as usual" gas scenario or the coal scenario.

This raises two questions:

1. What currently obstructs the NSW electricity market from delivering the lower cost outcomes associated with greater use of Distributed Energy?
2. What can the NSW Government do to facilitate more Distributed Energy and thereby deliver a lower cost, lower emission outcome?

This section considers these two issues.

8.1 Market barriers to Distributed Energy

It is often observed that energy consumers do not desire electricity for its own sake, but for the "energy services" that it provides: heating, cooling, cooking, lighting, etc. The market for these energy services is complex. It involves a wholesale (generation) market, a retail electricity market, and regulated monopoly (transmission and distribution) network service providers. There are also related markets for buildings, equipment and services that influence how much electricity is required. It is therefore not surprising that in such a complex market, inefficiencies and barriers are common.

The generation and retail components are the most efficient elements of this "energy services" market, and most closely approximate a perfectly competitive market with a large number of suppliers competing to supply a uniform "homogenous" good[11]. In practice, both the generation and retails markets are relatively concentrated and dominated by a small number of large firms with significant market power. While this market concentration is likely to lead to higher costs to consumers, it should not directly create additional barriers to Distributed Energy. On the other hand, policy responses to such market power can obstruct Distributed Energy as considered below in the discussion of regulatory failure.

By contrast, the "market" for network services (which are by their nature a monopoly) and for buildings and equipment do not remotely approximate perfectly competitive markets. It is particularly in these two areas that major market barriers exist.

The key types of market failures and barriers are described below:

1. **Cultural barriers.** In a perfect market, the behaviour of each consumer and each firm is independent. Each consumer is interested solely in satisfying their own individual preferences and each firm is solely interested in maximising its profit. In practice however, behaviour is partially dependent on traditions, habits and cultural norms, and the accepted practices of peers. This creates lags in the uptake of new Distributed Energy opportunities by consumers, and by network businesses that have traditionally focussed on providing network infrastructure rather than on investing in customer energy savings.
2. **Imperfect information**. In a perfect market, all relevant information is immediately and freely available to all consumers and producers. However, this is clearly not true in relation to energy use for buildings, equipment and related services.

[11] Or in economic terminology, "loss of consumer surplus".

Understanding energy use is complex, and consumers often make inefficient purchase decisions based on limited information.

3. **Split incentives**. The classic example for such inefficiencies is the so-called “landlord/tenant problem” where the landlord does not invest in energy saving measures because the tenant pays the electricity bill, and neither does the tenant invest in saving energy because they are uncertain that they will remain a tenant long enough to recover the investment. A similar phenomenon occurs at the macro level, where the generator, the network business, the electricity retailer and the consumer are all reluctant to invest in cost effective Distributed Energy technologies because no single party can capture all of the benefits.

4. **Payback gap**. In a perfect market, all parties have similar access to finance and their required rates of return and payback periods are simply dependent on individual preferences. In practice, specific institutions are often created to facilitate lower costs of capital, longer payback periods, and spreading of risk. The establishment of public power utilities for centralised electricity supply are common examples of this practice. However, the same finance structure is not usually available for Distributed Energy. On the one hand, consumers pay off centralised power stations and networks costs over 40 years (via their electricity bills), and are offered no choice in the matter. On the other hand, consumers must generally pay for Distributed Energy technologies directly, and may be unwilling or unable to pay – even when the payback period is, say, five rather than forty years.

5. **Prices do not reflect costs**. In a perfect market, all relevant costs are reflected in prices. In practice, this is often not true in the case of electricity supply. The most obvious example of this is the failure to include environmental “externalities” such as the cost of climate change due to greenhouse gas emissions. The NSW Government has partly addressed this barrier though the Greenhouse Gas Abatement Scheme and the Federal Government proposes to redress this nationally through the Carbon Pollution Reduction Scheme.

   However, external costs are not the only price related barrier to Distributed Energy. The price structure for electricity supply also distorts the functioning of the market. The cost of providing electricity at periods of maximum demand is very much higher than at times of low demand, as infrastructure costs are driven by peak demand. These cost differences are seldom reflected in prices. This means that Distributed Energy options that could address peak demand (such as load management and demand side response) are underutilised in favour of more costly centralised infrastructure provision.

6. **Regulatory Failure**. In perfect markets there is no need for regulation. However, in practice, all markets require some level of regulation to function efficiently. In natural monopoly markets, such as electricity networks, strong regulation is required to limit the abuse of market power. However, in many cases, the exercise of this regulation is biased in favour of centralised supply and against Distributed Energy. For example, in most states of Australia, including NSW, the regulation of networks via maximum price caps means that network businesses generally make more profit if customers consume more power and lose profit if customers save energy. Such regulatory approaches can create a powerful disincentive to Distributed Energy.

7. **Interaction between barriers**. In many cases, the above market failures can interact and reinforce each other such that the net result is greater than the sum of the parts.

8.2 Government policy measures to facilitate Distributed Energy

The major economic and environmental benefits of greater use of Distributed Energy, as described above, should motivate Government to address these significant market barriers. The recently adopted NSW Energy Savings Scheme is just such a policy initiative and can be expected to deliver a significant share of these benefits, as described in Section 4.1.

The following discussion considers additional policy instruments that might be applied to address the barriers to Distributed Energy.

1. Targets

Targets are often adopted by businesses, governments and individuals as a means of giving a higher priority to desired outcomes. Where the prevailing culture, habits or tradition are not delivering appropriate outcomes, targets can be an effective means of changing behaviour. For example, electricity distribution network businesses in NSW are subject to targets for reliability, price and profitability. This is a mechanism for the Government as both regulator and shareholder to drive the organisations to focus effort on these priority areas.

Targets also imply both measuring and reporting performance at regular intervals Targets can be “hard” such as those in the NSW Greenhouse Gas Abatement Scheme, which sets legally binding annual emissions limits, or “soft” such as the NSW Government’s aspirational greenhouse target of reducing greenhouse gas emissions to 2000 levels by 2025 and reducing them by a further 60% by 2050, or somewhere in between.

In order to stimulate Distributed Energy as suggested in the above scenarios, the NSW Government should complement the energy efficiency targets in the Energy Savings Scheme by setting firm targets for Distributed Energy development both in terms of energy (GWh per annum) and peak demand (MW). These targets should be adopted as soon as possible but need not be legislated. However, it is essential that annual targets are set and performance towards these targets is publicly reported at least annually.

The evidence in this report suggests that the NSW Government could have confidence in setting and reaching a target to meet all growth in projected energy consumption and projected peak demand through a combination of Distributed Energy and centralised renewable energy as mandated through the Federal Government’s Renewable Energy Target.

In order to ensure that this becomes a reality, a suitable agency within the Government, with appropriate skills, resources, commitment, and authority should be assigned responsibility for formulating and managing a coherent Distributed Energy Strategy.

Recommendation 1:

The NSW Government should adopt a target of meeting all forecast growth in energy consumption and peak demand between 2010 and 2020 from “green” energy sources; that is, renewable energy and Distributed Energy (including energy efficiency, demand side response, and cogeneration).

Recommendation 2:

The NSW Government should nominate a suitable agency within Government with appropriate resources and authority to coordinate its

Distributed Energy Strategy to implement these recommendations.

2. Information and facilitation

Policy options to overcome information barriers relating to Distributed Energy include:

- benchmarking of energy performance, to advise energy users of what constitutes efficient levels of energy consumption in different contexts
- energy performance labeling on appliances and equipment
- performance reporting (without targets)
- community education and awareness campaigns
- energy management systems
- case studies.

Most of these are currently applied to varying degrees in NSW and each could be expanded. However, arguably the biggest information barrier in relation to Distributed Energy is not at the consumer level but at the policy level. Reliable information about the current practice and future potential of Distributed Energy is not available.

Reflecting this inadequacy of information, this report has been forced to rely on partial, inconsistent and outdated information in assessing the potential for expanding Distributed Energy in NSW. Given the likely potential for Distributed Energy to deliver major economic and environmental benefits, this deficiency should be urgently addressed.

Facilitation is intended to make it easier for consumers, businesses and service providers to access and deliver Distributed Energy options. This goes beyond information provision, but stops short of offering specific incentives, and is generally intended to support parties already seeking to adopt Distributed Energy options. This is the first tier of a Distributed Energy strategy. Facilitation is often aimed at reducing transaction costs, managing risk and building confidence. Possible facilitation measures include:

- high level management commitment to reducing administrative and cultural barriers (e.g. through the NSW Government's Sustainability Advantage Program)
- audits, advice and technical assistance
- accreditation of service providers, to provide potential clients with greater confidence (e.g. through the Clean Energy Council's accreditation of PV installers)
- training and skills development (e.g. through the NABERS assessor training program)
- networking of customers and product and service providers (e.g. through seminars, conferences, websites)
- government endorsement of products, to inspire greater consumer confidence
- community engagement (e.g though the Sustainability Street program).

- standardised agreements for provision of Distributed Energy services, in order to reduce legal and negotiation costs.

Numerous facilitation initiatives are already provided by government and other organisations, but there is no overall coordination or evaluation of their effectiveness. This leads to confusion, overlap, gaps and inefficiency.

Recommendation 3:

The NSW Government should undertake and publish a comprehensive annual NSW Distributed Energy Review. This Review should include:

- ***a detailed resource assessment of Distributed Energy potential in NSW***
- ***a detailed assessment of current Distributed Energy practice in NSW***
- ***an overview of international best practice in programs and policy, and***
- ***an evaluation of potential policy measures for the adoption of Distributed Energy.***

3. Incentives

Incentive measures are intended to stimulate behaviour change. They are economically beneficial wherever the total benefits of the resulting behaviour change exceed the total cost of providing the incentive. Examples of incentives include:

- cash rebates (such as the Climate Change Fund Residential Rebate program)
- competitive subsidy bidding programs (such as the Climate Change Fund Green Business Program)
- financial support for research and development
- loans and financial guarantees
- expedited planning processes
- public recognition and awards (such as the NSW Government Green Globe awards)
- prizes
- community rewards, where a whole community is rewarded, for example provision of a new local playground as a result of a collective effort to save energy.

Incentives are often regarded as a “second best” policy instrument as they generally aim to counteract market barriers rather than reduce barriers. However, incentives can still be very cost effective. For example, the Energy Savings Fund component of the NSW Climate Change Fund is reported to have achieved 189,376 MWh of annual electricity savings at an average cost of $15/MWh (DECC 2008, p.21). This suggests a very cost effective outcome when compared to an average retail electricity cost of $80/MWh for business and $150/MWh for residential consumers.

However, there remains large untapped potential to use incentives to support Distributed Energy. As with facilitation, the measurement, evaluation and reporting of the effectiveness of incentives is incomplete and inconsistent. There is very little use by energy utilities of incentives for Distributed Energy when compared to the increasing use of incentives for water saving by water utilities.

Recommendation 4:

The NSW Government should maximise incentives for Distributed Energy by:

- ***accelerating and better targeting existing programs (such as the NSW Climate Change Fund).***
- ***making greater use of non-financial incentives and community engagement, and***
- ***encouraging NSW Government-owned electricity network operators to redirect part of their capital budgets towards incentives for Distributed Energy.***

4. Pricing

As noted in Section 8.1, there are two key policy priorities in addressing price-related market failures:

- applying an appropriate price on carbon emissions to internalise the external environmental cost of greenhouse gas emissions.
- reforming of electricity price structures to reflect more accurately the true cost of network and generation capacity constraints at time of peak demand or supply interruptions.

The first of these has been addressed in part by the NSW Greenhouse Gas Abatement Scheme (GGAS) and should be more comprehensively addressed by the proposed Carbon Pollution Reduction Scheme (CPRS). However, just as the effectiveness of the GGAS was undermined by a number of concessions which reduced the effective cost of carbon and the actual emission reduction achieved, so too it is likely that many years will pass before the CPRS sends strong price signals. Until electricity prices adequately reflect the full cost of carbon emissions, there will be a strong economic case for "second best" mechanisms to be applied to offset this bias against lower emission distributed energy options.

Given the pre-eminence of forecast peak demand growth in driving proposed electricity investment decisions in NSW, it is crucial that electricity prices are fundamentally reformed. This relates to both retail and network prices.

There have been numerous time-of-use pricing trials by each of the NSW distribution network businesses, but the deployment of both "smart meters" and time-of-use pricing has been slow. For example, Energy Australia has reportedly installed approximately 400,000 time-of-use meters, but has suspended this rollout pending resolution of policy and regulatory issues. Moreover, of the smart meters already in place, only about half are currently subject to time-of-use pricing.

Recommendation 5:

The NSW Government should continue to advocate for an effective and adequate national price on carbon emissions in the context of the CPRS. Until this is achieved it should reinforce NSW-based measures (such as the NSW Greenhouse Gas Abatement Scheme) that redress the price bias against lower emission Distributed Energy options.

Recommendation 6:

The NSW Government should encourage its distribution network businesses to accelerate the deployment of smart meters and the introduction of time-of-use pricing, (including dynamic peak pricing at times of very high demand offset by lower prices at other times). It should also encourage Transgrid to reform transmission network pricing to strongly reflect peak load events in its prices.

5. Regulation

There have been numerous recent reports and submissions on regulatory barriers to the development of Distributed Energy. (See for example, Dunstan and Abeysuriya 2007, City of Sydney 2009). It is beyond the scope of this report to canvass these proposals in detail. However, the following measures are within the power of the NSW Government and are crucial to removing regulatory barriers to Distributed Energy.

Recommendation 7:

The NSW Government should request that the Australian Energy Market Commission (AEMC) change the National Electricity Rules to remove regulatory biases against Distributed Energy by:

- ***removing network regulatory incentives which are contrary to the consumer interest (such as the current link between network profits and customer electricity sales volume).***
- ***allowing network businesses to invest in Distributed Energy options up to five years prior to the corresponding trigger point for network augmentation.***
- ***requiring network businesses to implement all available cost effective Distributed Energy options with lower greenhouse gas emissions prior to augmenting the network.***

9 Conclusion

Meeting the growth in demand with Distributed Energy is significantly cheaper than building a coal fired power station or meeting electricity growth needs with large gas fired power stations. This is primarily because of significant savings which can be achieved on network augmentation costs.

The Distributed Energy scenarios also have lower greenhouse emissions, particularly if they are combined with reducing coal fired generation. The maximum Distributed Energy scenario considered (energy efficiency, cogeneration, demand side response and reducing coal capacity by 1000 MW) saves 7 million tonnes of emissions and $0.5 billion compared to business as usual.

However, the economic and greenhouse gas savings associated with the Distributed Energy scenarios will not be achieved unless there is deliberate and effective policy reform. This policy reform does not need additional government funding, but it does require strong and sustained political leadership to break with centralised energy practices of the past.

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Appendix 1 – Assumptions

Default network augmentation cost	0.3	$m / MW/ yr
Variable costs per MWh (pool)	20	$/MWh
Rate of Return	10%	
Industrial electricity price	65	$/MWh
Pool marginal emissions	0.9	tonnes/ MWh
2020 industrial peak summer demand (Australia)	1760	MW
NSW proportion of NEM generation and consumption	0.32	
Average capacity factor wind	35%	
Capacity factor of existing coal generation	90%	